

Winter Food Habits of Bobcats in North Carolina

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ABSTRACT.— Carcasses of 505 bobcats, *Felis rufus* (229 ♀, 276 ♂), were collected from October through March in 1978-79 and 1979-80. Stomach contents were analyzed and the results summarized by physiographic regions, sex, and age. The top eight prey groups, ranked by frequency of occurrence, were rabbits, *Sylvilagus* spp.; birds; cotton rats, *Sigmodon hispidus*; white-tailed deer, *Odocoileus virginianus*; rodents; gray squirrels, *Sciurus carolinensis*; raccoons, *Procyon lotor*; and opossums, *Didelphis virginianus*. Ranked by frequency of occurrence, rabbits were first in the Coastal Plain and cotton rats first in the Piedmont Plateau. Adult male bobcats consumed larger prey than did adult females or kittens. Kittens tended to exploit smaller and a wider variety of prey items than did adults.

INTRODUCTION

Because of restrictions placed on harvesting many species of spotted cats, the value of bobcat, *Felis rufus*, pelts increased greatly on the international fur market. In 1977 concern about the national status of bobcats prompted the Council on International Trade of Endangered Species of Flora and Fauna (CITES) to list them as a species that could become threatened with extinction unless trade was subject to regulation. As part of a program to learn more about the status and ecology of bobcat populations in North Carolina, we initiated a study of bobcat food habits based on analyses of trapper-harvested carcasses. Other aspects of our research program are reported elsewhere (Lancia et al., in press).

Previous food habits studies in the southeastern United States reported rabbits, *Sylvilagus* spp., as the major food item (Progulske 1952; Davis 1955; Fritts 1973; Buttrey 1974; Fox and Fox, in press). In addition, cotton rats, *Sigmodon hispidus*; white-tailed deer, *Odocoileus*

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virginianus; squirrels, *Sciurus carolinensis*; voles, *Microtus* spp.; and birds were frequently identified food items (Progulske 1952; Davis 1955; Kight 1962; Fritts 1973; Buttrey 1974; Miller and Speake 1978).

MATERIALS AND METHODS

Skinned bobcat carcasses were provided by fur dealers and trappers during the 1978-79 and 1979-80 trapping seasons. The carcasses were weighed, sexed, and necropsied. Adult and kitten (≤ 8 months) age classes were assigned using lacteal tooth replacement criteria (Crowe 1975).

Stomach contents, prepared following Korschgen (1980), were identified to order and, when possible, to species. Data were recorded by percent frequency of occurrence because not all material in each stomach could be identified, hence percent volume could not be measured precisely. Food items were identified macroscopically or, when necessary, mammals were identified by microscopic examination (at 100x and 400x) of sample hairs using hair keys (Spiers 1973; Moore et al. 1974).

STATISTICAL ANALYSES AND INTERPRETATION

The state was divided into three physiographic regions (Stuckey 1965), and the data were examined at statewide and regional levels. Comparisons of carcass weights were made using least-squares fit to a fixed-effect linear model using the Scientific Analysis System (SAS; Barr et al. 1979). Weights of kittens and adults were analyzed separately. Food items were ranked by frequency of occurrence, and differences in ranks were evaluated using Wilcoxon's Rank Test (Wilcoxon 1945). Chi-square tests were used to evaluate differences in prey selection. Calculation of expected frequencies of prey items for chi-square tests were based on an assumed equal probability of occurrence in a particular sex and age group.

Caution must be observed when making inferences about the proportion of food items present in the diet based solely on stomach analyses because: 1) smaller prey species are frequently under represented in stomach analyses due to differences in digestibility (Weaver and Hoffman 1979; Merriwether and Johnson 1980); 2) some food items may have been eaten incidentally as trap bait, garbage or carrion; and 3) frequency of occurrence data cannot be used to evaluate food preferences without estimates of both prey abundance and availability.

RESULTS AND DISCUSSION

From October through March 1978-79 and 1979-80, 505 bobcats (229 ♀, 276 ♂) were collected. Weights between samples collected each year were not different ($p > 0.05$); therefore, the samples were pooled for subsequent analyses. Among the three physiographic regions, weights

were different ($p < 0.01$) for both age groups, but no clear biological significance in the trends was apparent (Tables 1, 2). Weights of females were less than males ($p < 0.01$) for both adults and kittens. Sex ratios of adults and kittens were not different among regions or between yearly samples ($p > 0.05$).

Table 1. Analysis of variance for weights of skinned carcasses of 505 bobcats collected in 1978-79 and 1979-80 in North Carolina.

Adults (N=355)			Kittens (N=150)		
Source	DF	F value	Source	DF	F value
Sample	1	0.02	Sample	1	1.75
Region (Sample)	4	4.13**	Region (Sample)	4	5.24**
Sex (Region)	3	134.74**	Sex (Region)	3	3.84**

** Significant at the $P < 0.01$ level.

Table 2. Skinned weights (kg) of 505 bobcats collected in the three physiographic regions of North Carolina.

Region	Age Class	Sex	N	Mean	SE
Coastal Plain	Kittens	♀	47	3.9	0.1
		♂	58	4.3	0.1
	Adults	♀	131	5.8	0.1
		♂	153	8.0	0.1
Piedmont	Kittens	♀	10	3.4	0.2
		♂	23	4.0	0.2
	Adults	♀	26	5.9	0.2
		♂	33	8.2	0.2
Mountains	Kittens	♀	6	3.0	0.3
		♂	6	2.9	0.4
	Adults	♀	9	4.9	0.1
		♂	3	9.0	1.1

Of 473 stomachs suitable for examination, 398 (179 ♀, 219 ♂) contained food. This sample comprised 257 adults and 141 kittens. Stomachs containing food were collected from 50 of the 100 counties in the state, with the largest samples in the Coastal Plain (307) and Piedmont Plateau (73) regions and the smallest sample (18) from the Mountains (Fig. 1).

Some disproportionate sampling was evident in these regions, with one or two counties contributing more than a third of the total number

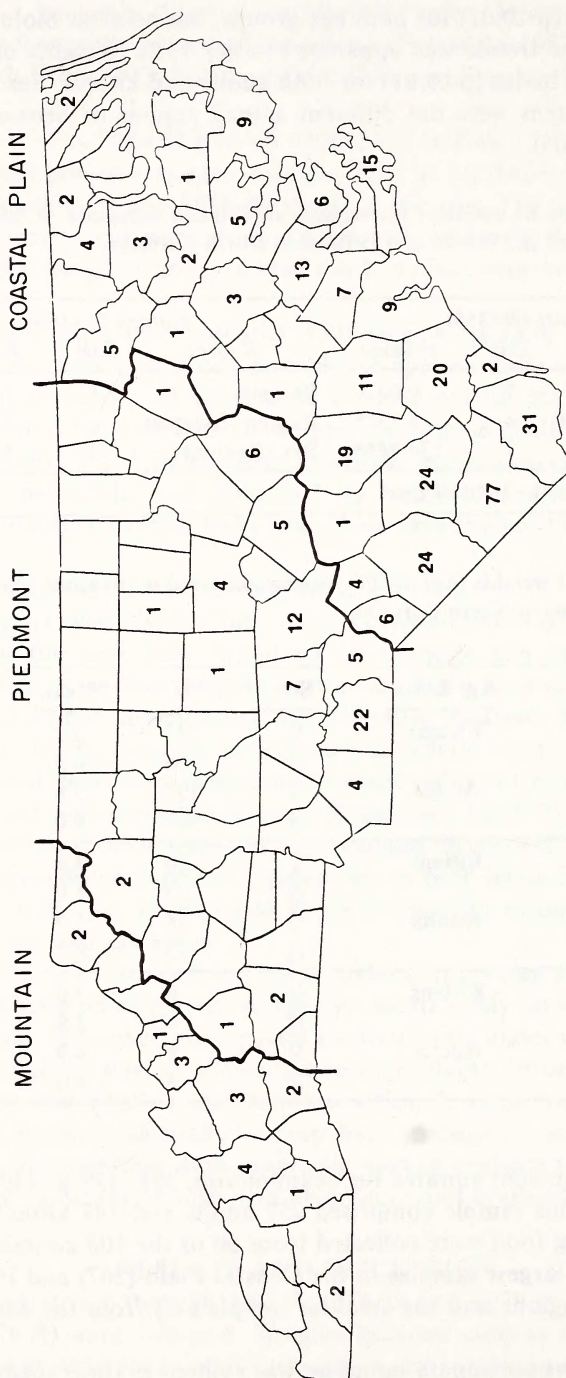


Fig. 1. Number of bobcat stomachs containing identifiable food items collected in each physiographic region, 1978-79 and 1979-80.

of stomachs for the region. To determine if these county samples biased the total regional sample, we ranked the top eight food items in these counties and compared them to the top eight food items in the remaining counties of the region. The differences in ranks were not statistically significant ($p > 0.05$).

Mammals were the most frequently represented food group, with 20 species identified statewide (Table 3). The top eight food items ranked by frequency of occurrence were rabbits; birds; cotton rats; white-tailed deer; small rodents; gray squirrels; raccoons, *Procyon lotor*; and opossums, *Didelphis virginianus*. Small numbers of reptiles, amphibians, fish, and insects also were identified.

Rabbits were the most frequently identified species in bobcat stomachs (Table 3, Fig. 2). The percent occurrence of rabbits decreased from the Coastal Plain to the Mountain region ($p < 0.05$), probably in response to differences in abundance of rabbits in the regions rather than to shifts in prey preference. The low frequency (5.6%) of rabbits in stomachs from the Mountain region contrasted the findings of Progulske (1952)

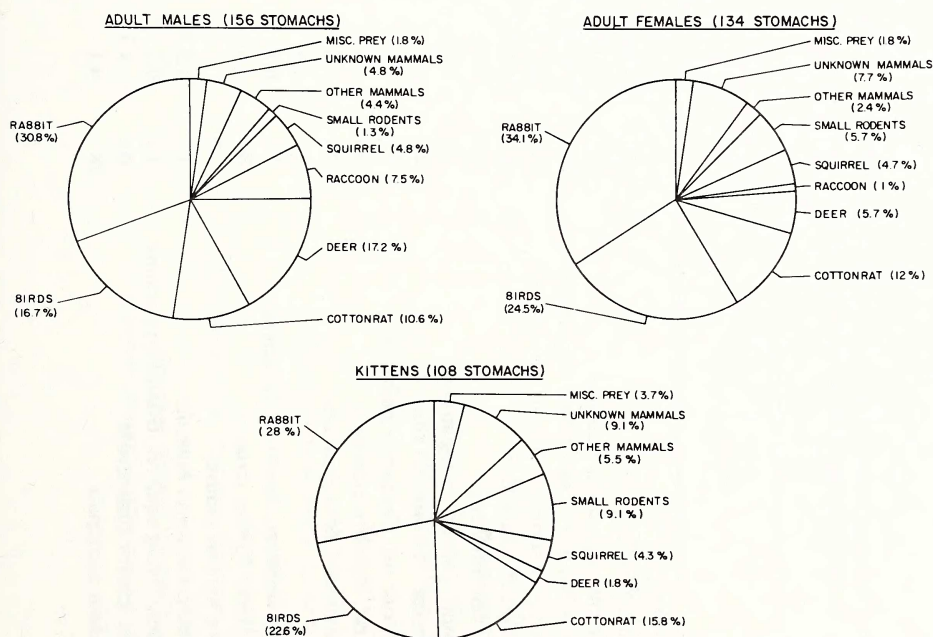


Fig. 2. Relative percent frequency of occurrence of food items identified in adult male, adult female, and kitten bobcat stomachs. Small rodents include voles, marsh rice rat, and mice; other mammals include opossum, muskrat, pig, rats, chipmunk, flying squirrel, and beaver; miscellaneous prey include reptiles, amphibians, fish, and arthropods.

Table 3. Frequency and percent occurrence of food items in 398 bobcat stomachs from three physiographic regions of North Carolina, October through March, 1978-79 and 1979-80.

Items	Coastal Plain (N=307)		Piedmont (N=73)		Mountain (N=18)		Statewide (N=398)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
MAMMALS								
Rabbits, <i>Sylvilagus</i> spp.	162	52.8	24	32.9	1	5.6	187	47.0
Cotton rat, <i>Sigmodon hispidus</i>	41	15.0	29	39.7	0	-	75	18.8
White-tailed deer, <i>Odocoileus virginianus</i>	46	13.4	10	13.7	3	16.7	54	13.6
Eastern gray squirrel, <i>Sciurus carolinensis</i>	25	8.1	1	1.4	2	11.1	28	7.0
Raccoon, <i>Procyon lotor</i>	16	5.2	3	4.1	0	-	19	4.8
Voles, <i>Microtus</i> spp.	10	3.3	1	1.4	3	16.7	14	3.5
Opossum, <i>Didelphis virginianus</i>	4	1.3	3	4.1	2	11.1	9	2.3
Field mice, <i>Peromyscus</i> spp.	4	1.3	3	4.1	0	-	7	1.8
Marsh rice rat, <i>Oryzomys palustris</i>	5	1.6	1	1.4	0	-	6	1.5
Muskrat, <i>Ondatra zibethica</i>	5	1.6	0	-	0	-	5	1.3
House mouse, <i>Mus musculus</i>	2	0.6	0	-	0	-	2	0.5
Pig	2	0.6	0	-	0	-	2	0.5
Eastern woodrat, <i>Neotoma floridana</i>	1	0.3	0	-	1	5.6	2	0.5
Chipmunk, <i>Tamias striatus</i>	0	-	1	1.4	1	5.6	2	0.5
Eastern harvest mouse, <i>Reithrodontomys humilis</i>	1	0.3	0	-	0	-	1	0.2
Southern flying squirrel, <i>Glaucomys volans</i>	1	0.3	0	-	0	-	1	0.2
Beaver, <i>Castor canadensis</i>	0	-	1	1.4	0	-	1	0.2
Unknown mammals	28	9.1	10	13.7	4	22.4	42	10.5

BIRDS

Northern bobwhite, *Colinus virginianus*
 Ruffed grouse, *Bonasa umbellus*
 Chicken
 Brown-headed cowbird, *Molothrus ater*
 Unknown birds

REPTILES

Black racer, *Coluber constrictor*

AMPHIBIANS

Unknown frog

FISH

Unknown spiny-rayed fish
 Unknown soft-rayed fish
 Centrarchidae
 Gizzard shad, *Dorosoma cepedianum*

ARTHROPODS

Acarina (Tick)

Diptera

Hymenoptera (Ant)

Unknown insects

4	1.3	3	4.1	0	-	7	1.8
0	-	0	-	2	11.1	2	1.8
1	0.3	0	-	0	-	1	0.2
0	-	1	1.4	0	-	1	0.2
97	31.6	13	17.8	5	27.8	115	28.9
0	-	1	1.4	0	-	1	0.2
1	0.3	0	-	0	-	1	0.2
1	0.3	0	-	0	-	1	0.2
1	0.3	0	-	0	-	1	0.2
1	0.3	0	-	0	-	1	0.2
1	0.3	0	-	0	-	1	0.2
1	0.3	0	-	0	-	1	0.2
1	0.3	0	-	0	-	1	0.2
2	0.6	1	1.4	0	-	3	0.7

who examined 25 stomachs from the Pisgah and Nantahala National Forests and reported 24% contained rabbits.

Birds were found in a greater percentage of the stomachs in 1978-79 than in 1979-80 ($p < 0.05$). In both years the percent occurrence of birds was greater in stomachs from the Mountains than from the Piedmont region ($p < 0.05$). Birds were found in proportionately more adult female and kitten stomachs than in adult male stomachs (Fig. 2). Although this relationship was not statistically significant in our study, Fritts and Sealander (1978) also observed a similar trend in Arkansas.

Statewide, cotton rats were the second ranking mammal by frequency of occurrence. A high occurrence of cotton rats in kitten stomachs, although not significantly greater than in adults ($p > 0.05$), reflects a trend in prey size similar to that observed for birds, i.e., smaller prey occurred more frequently in adult females and kittens than in adult males.

The percent occurrence of cotton rats was highest in the Piedmont region where this species was the major food item (Table 3). Beasom and Moore (1977) and Miller and Speake (1978) have shown that in habitats where cotton rats were the most abundant small mammal, they were the major prey item. Cotton rats ranked second in frequency in the Coastal Plain region, but were found less than one-third as frequently as rabbits, the major food item (Table 3). Cotton rats were not found in stomachs examined from the Mountain region.

Deer were identified in stomachs from all regions and ranked third statewide among mammals in frequency of occurrence (Table 3). Although a major food item in the Mountain region, the percent occurrence of deer was not significantly different ($p > 0.05$) from that found in other regions.

Progulske (1952) reported deer as a winter food of bobcats in western North Carolina and Virginia and suggested they were eaten as carrion. Based on 124 scats from Virginia, he concluded deer were consumed primarily during the fall and winter rather than in spring or summer, and suggested hunting season casualties on deer might be partially responsible. Managers of North Carolina wildlife areas reported 16 deer killed by bobcats in 1968 (Barrick 1969).

Deer were found more frequently in stomachs of adult males than in adult females or kittens (Fig. 2). In the Coastal Plain, observed frequencies of deer were greater for adult males and less for adult females and kittens than expected frequencies ($p < 0.05$), possibly indicating a selective preference for deer by adult males. Observed versus expected frequencies of deer were not different ($p > 0.05$) between the Piedmont or Mountain regions, probably due to the small number of stomachs examined from these regions.

Greater use of deer by adult male bobcats may be related to differences in average weight and/or size of home ranges of males and females. Weights of males were larger than those of females, and a telemetry study in the Coastal Plain region indicated the average size of adult male home ranges ($N=5$) was about 41% larger than home ranges of adult females ($N=3$) (Lancia et al., in press). Similar ratios of male to female ranges were observed by Bailey (1974) in Idaho, Hall and Newsum (1976) in Louisiana, and Miller (1980) in Alabama.

Gray squirrels ranked fourth in overall frequency of occurrence among mammals (Table 3). The relative percent frequencies of squirrels in this study were similar for all bobcat sex and age groups (Fig. 2). Squirrels were found in two stomachs from the Mountain region and one stomach from the Piedmont region. Similarly, Progulske (1952) found squirrels in two of 25 stomachs he examined from western North Carolina. In the Coastal Plain region, squirrels ranked fourth in frequency of occurrence.

Raccoons ranked fifth among mammals in the statewide sample and occurred only in stomachs from the Coastal Plain and Piedmont regions (Table 3). Raccoons occurred primarily in adult male stomachs and were not found in any kitten stomachs (Fig. 2). The greater occurrence of raccoons in adult male stomachs again may reflect the greater weight and larger home range of male bobcats.

Small rodents were infrequent food items. Voles, *Microtus pennsylvanicus* and *M. pinetorum*, were the most frequently identified small rodents and occurred in stomachs from all regions. Voles ranked first (with deer) in percent occurrence in the Mountain region (Table 3) and were found primarily in stomachs of kittens and adult females. In the Coastal Plain, adult females and kittens had greater observed than expected frequencies of voles ($p<0.05$). Other small rodents were prey of adult females and kittens but were seldom taken by adult males (Fig. 2). Fritts and Sealander (1978) also reported that occurrences of rats and mice were greater in the stomachs of adult females and kittens than in adult male bobcats.

We examined 141 kitten (59% males) stomachs containing food. Like adults, kittens relied primarily on rabbits and cotton rats for food (Fig. 2); however, the occurrence of some items in kitten stomachs was notably different from adults. Deer occurred in only three (2.1%) kitten stomachs, compared to 51 (19.8%) adult stomachs. Two intermediate-sized prey species, raccoons and opossums, occasionally were eaten by adults but were absent or rarely found in the kitten sample (Fig. 2). The low occurrence of large and intermediate-sized prey species in kitten stomachs probably reflected an inability of kittens to capture larger-sized prey. The infrequent occurrences of these prey species in kitten stom-

achs may have been the result of food provided by the adult female, or evidence of feeding on carrion.

A greater variety of food items was eaten by kittens than by adults. For example, kitten stomachs represented 28% of the total sample, but accounted for 71% of the occurrences of *Peromyscus* spp. and 57% of the voles. Fritts and Sealander (1978) also reported a greater use of cricetid rodents by kittens than by adults.

Although prey species in the cotton rat-rabbit size range (0.1-2.0 kg) were major components in the diet of all bobcat sex and age classes, some differential selection was evident. Kittens and adult females were the principal consumers of the smallest prey (<0.1 kg), while the largest prey species (>2.0 kg) were consumed most frequently by adult males (Fig 3). The greatest occurrence of prey in the 0.1 - 2.0 kg range may represent a specialization of bobcats for a selected prey size (Miller and Speake 1978).

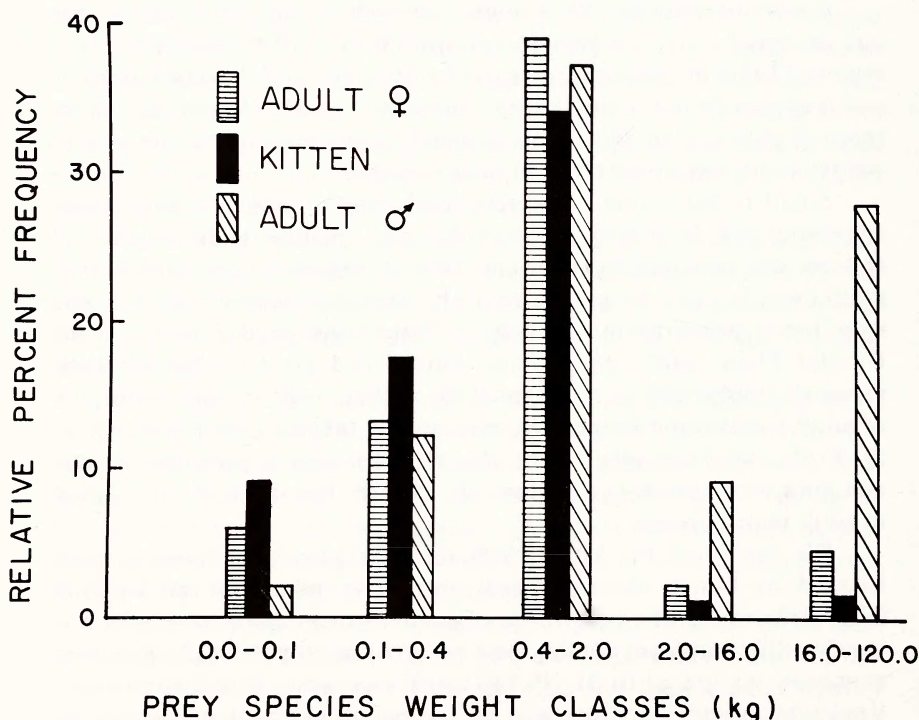


Fig. 3. Relative percent occurrences of different weight classes of mammalian prey items identified in adult male, adult female, and kitten bobcat stomachs. Species included in the weight (kg) classes are: 0.0-0.1 (mice); 0.1-0.4 (chipmunk, cotton rat, woodrat, and Norway rat); 0.4-2.0 (squirrel, rabbit, muskrat); 2.0-16.0 (opossum, raccoon); and 16.0-120.0 (deer).

CONCLUSIONS

The results of our study are similar to previous winter food habits studies in the southeastern United States and indicate rabbits, birds, cotton rats, and deer were the top four prey items by percent occurrence in stomachs of bobcats collected statewide in North Carolina during winter. Furthermore, adult males appeared to select the larger prey items (>2.0 kg), and adult females and kittens the smaller prey items (<0.1 kg). All sex and age classes apparently preferred intermediate-sized prey (0.1 - 2.0 kg).

The identification of food habits has management implications. The prey species most used by bobcats as food items were species adapted to early successional stages (e.g., rabbits, cotton rat, and deer). An interpretation based on prey selection suggests bobcats are not a climax species, but rather a subclimax species, benefitting from land management practices that maintain early successional habitats.

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